Dialog Designs in Virtual Drama: Balancing Agency and Scripted Dialogs

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Abstract. Scripts are automatically generated by a story generator and subsequently played by virtual agents. The scripts for actors consist of two parts: movements and dialogs, however, the dialogs are insufficiently addressed in current research of story generation, thereby limiting the generated stories. Therefore, our initial goal was to enable story generators to generate dialogs as sets of character-based actions that are integrated with original story plots. This paper presents a speech-act-based dialog generation framework to define the relationship between dialogs and story plots. In addition, we introduce the manner in which agents may improvise scripted dialogs by selecting various courses of actions. Lastly, a sample scenario was generated according to this framework and demonstrated by virtual agents with the Unreal Development Kit. Our initial results indicated that this framework maintains a balance between agency and scripted dialogs, and that improvised dialogs of virtual agents do not affect the consistency of stories.

Keywords: speech act theory, dialog generation, virtual drama.

1 Introduction

The rise of intelligent virtual agents has formed a new interdisciplinary research community comprising artificial intelligence, computer graphics, cognitive science, natural language processing, and narrative theories.

Although the future direction of virtual agents may vary according to the major domain of researchers, a significant domain is virtual drama because it occurs in existing applications, such as computer games, emotion counseling, and simulation-based training. We identified virtual drama as a play with the following characteristics:

1. Virtual environments: rendering computer graphics with either realistic or cartoon-style pictures as the scenes in the play. The virtual environments often serve as the engine that integrates other components, such as camera controllers and physics.
2. Virtual actors: virtual agents may be implemented by various methods in virtual environments and intended to act as characters in the play. They are equipped with the abilities to display believable gestures and facial expressions, and to synthesize voices and other interactions.

M. Beer et al. (Eds.): AEGS 2011, LNAI 7471, pp. 63–78, 2012.

3. Play scripts: the actions of virtual actors and virtual environments are described in the play scripts, which are either manually written or automatically generated. Although they differ from movie scripts, which are intended for human actors and directors, play scripts in virtual drama are often defined with formalisms and/or markup languages, for example, PDDL [14] in the planning domain and BML [29] to describe the action timing of virtual actors.

Although the virtual environments and virtual actors are important research topics in virtual agents, we focused on the generation of the third part, which is identified as story generation or narrative generation in academic terms.

The need for automated story generation is because audiences consume stories markedly faster that human authors write stories. The scripts are automatically generated with the use of a story generator and are subsequently played out by virtual actors who are situated in virtual environments. Therefore, we argue that story generation is the starting point for virtual drama to become completely automated and to provide on-demand digital content.

However, although recent research in story generation applies various types of planning [8][25] and theories in narrative analysis to generate plots, these plots contain only high level actions that consist of physical actions only , and the dialogs between characters are often ignored or are hand-crafted, resulting in speechless or domain-specific scenarios. The high level actions require human authors to fill in the dialogs; however, the dialogs of the characters are limited to current storylines, and are difficult to apply to other generated stories.

To address this problem, the main aim of our research was to model a generative framework of dialogs to generate dialogs for various stories and actors without losing its generality. Because the entire domain of natural language generation is beyond our research problem, our framework is based on a simplified yet well-structured form of language that is known as speech acts, which are treated as ordinary actions in the planning domain, therefore, the state-of-the-art techniques of story planning may use them during the planning process without several modifications.

In particular, this novel dialog framework is flexible to both virtual actors and story plots. It allows virtual agents to choose more detailed dialogs based on internal character profiles and the play scripts, and also allows human authors to specify constraints at the level of story discourse.

The remainder of this paper is described as follows: section 2 presents reviews of related literatures in the domains of agent communication and story generation, which focuses our work and identifies its scope; section 3 provides a description of our desiderata and an explanation for the selection of hierarchical speech acts as the foundation of our framework; section 4 provides a formal representation of virtual drama and our dialog framework in Z notation; section 5 presents the application of this framework to an abstract scenario to evaluate the use of our model to generate balanced dialogs between characters and plots;

and a sample scenario is illustrated in section 6 to demonstrate the whole framework. Lastly, section 7 offers conclusions by summarizing our main findings and future work.

2 Related Work

2.1 Narrative Generation

In general, research of narrative generation is based in literary structuralism. Based on their work, a narrative world is described by a series of events, which are known as fabula. The pieces of fabula that are chosen by storytellers to be retold to the audience are identified as sujet. Because story discourse (the sequence of sujet) may differ from fabula in temporal order and appearance (for example, not every piece of fabula will appear in sujet), various stories may be generated, including those based on the same fabula.

Fabula and sujet, when formulated as actions, may be generated with POP-based planning. Although structuralists [7][24] analyzed stories as a set of specific patterns of sujet, the goal of narrative generation is to generate stories according to these patterns. The further decompositions of these overall story patterns lead to the formulation of causal constraints in planning. By contrast, the continuity of character intention that is expressed in sujet is also a crucial factor to stories and is identified as intentional constraints by Riedl et al. and was utilized by their story planner IPOCL [25].

The POP-based narrative planning yields optimal stories, which may be further processed into various styles of sujet, such as suspense. Riedl extended his method by incorporating vignettes [27], which are considered good scenarios and used as existing plan fragments during the planning process, enabling the story to be reused. However, the actions used by planners are defined as major events at the level of overall fabula rather than at the level of sujet, which consists of lines of dialogs between characters.

2.2 Interactive Narratives

A parallel trend of research in narrative intelligence is interactive narratives, which focuses on interactions between human users and virtual actors. In the I-Storytelling system [4], each virtual actor interacts with users and other virtual actors based on a pre-scripted HTN plan, allowing others to change its behavior based on the actual interactions on-stage. The sujet emerges from real-time interactions without definite fabula, and therefore, this method is also identified as emergent narratives. The method of emergent narratives leads to multiple possible fabula, as it may generate inconsistent stories with the same set of HTN plans.

The formulation of interactive narratives may be more suitable in describing dialogs because dialogs are a type of interaction. As the number of pre-scripted

interactions increase, users may experience varied dialogs. In most applications, the definition of story directions at various levels is still preferred to avoid virtual actors from becoming random chat bots and thereby losing the focus of the intended stories. Therefore, a drama manager is required to determine appropriate interactions according to the current development of stories. With fine-grained interaction segments, such systems can yield highly interactive stories of excellent quality, as exemplified by Faade [19]. However, in contrast to those actions which are general events in POP-based story planning, all the dialogs and other interactions in interactive narratives are domain (story) specific. Consequently, recent development about dialog generation in interactive narratives demonstrates the differences among characters regarding various forms of expressions [5], character archetypes [28], personality [18], culture [11], and multi-modal dialogs [22]. These dialogs require time to build and refine, however, they are difficult to reuse in new stories due to the lack of explicit notations related to high level plots because they intertwine with implicit and possibly multiple fabula.

2.3 Simulation-Based Training

By contrast, negotiation formalisms from agent communication languages were introduced into applications of simulation-based training [30]. The virtual actors must interact with users through protocols of normal coordination and communication because their goal is to train human users with virtual agents in virtual environments. Although the actual lines of dialogs are pre-recorded, the virtual actors reason about their communication with users and evaluate it as various, based on explicit task models of standard operation procedures. A set of negotiation-related speech acts were used to allow users to negotiate with virtual actors, , and either the actors or the users interacted with each other through speech acts and related parameters that were defined in the task models, and the speech acts of the user were identified automatically with voice recognition and further natural language processing. If negotiated properly, the virtual actors take various courses of actions and hence change the following story.

This method is applied in several related training projects [10][31]. From our point of view, the task models and speech acts are defined explicitly within interactions, and the gestures, facial expressions, and other movements of virtual actors are configured independently in the visualization process, making this dialog model modularized and plausible to stories. Based on this research, our study introduces a speech act classification system to serve as the foundation of the dialog framework that is revealed in the next section, and to integrate it with the narrative generation process.

3 Dialog Framework

In this section, we clarify the purpose and the definition of dialogs with formalisms.

Dialogs, which are either a monologue or a conversation involving multiple participants, are conducted in any part of the narratives and describe a part of the story from the point of view of particular characters. The presented story may change, depending on the points of view of various characters [23]. However, Austin indicated that the purpose of statements is not only to describe, but also to do things with words [1], and that the purpose of dialogs in narratives is not just to describe the story, but also to represent the actions of characters toward the narrative world. To model these actions, we used the theory of speech acts and viewed dialogs as sequences of various speech acts.

Although the model of domain knowledge in dialog contents were conducted in recent research [17], the speech acts in interactive narratives are usually customized according to the tasks in stories [6][19][30] in an ad-hoc manner without a determined hierarchy or relations among the various speech acts, therefore, speech acts are difficult to use by either story planners or virtual actors that intend to emerge narratives. Considering these findings, we progressively introduce what we assume to be the essential classification of speech acts, and the manner in which it is applied to build a consistent schema that captures the dialogs in narratives.

Although we intended to only allow virtual actors to adopt and mimic the structures of human dialogs to generate similar sentences, we first categorized and identified the relations among numerous speech acts that are used by humans. Our approach was based on Ballmer and Brennenstuhls speech act classification [2] because it provided explicit relationships among various groups of speech acts. Their classification identified four main groups of speech activities as hierarchical linguistic functions. The functional effect of each category of speech acts does not overlap although a semantic verb may appear in various categories. Consequently, we believe it is possible for story generators to select corresponding categories based on the effects of speech acts. We explain groups of speech acts in the context of narratives, as follows:

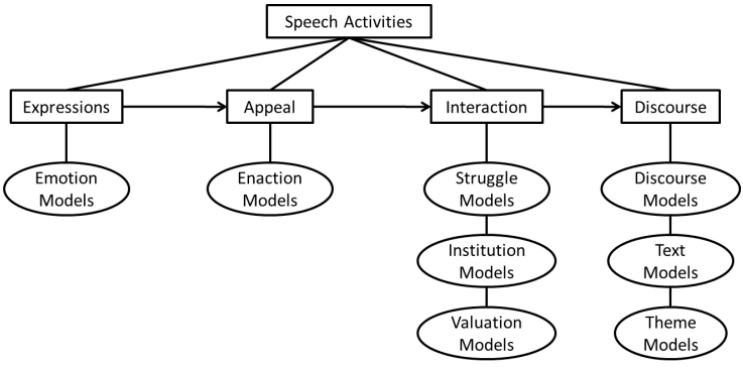


Fig. 1. Speech Act Classification from [2]

- Level1-Expression: including all emotional reactions. Expression contains the most primitive and direct speech acts that present the profiles of characters, such as angry, afraid, and grateful.
- Level2-Appeal: Appeal represents speech acts in a focused sense, where the speaker attempts to influence and control the listener (for example, order, threaten, encourage).
- Level3-Interaction: similar to Appeal, however, the listener can influence the speaker, whereas the speaker may try to avoid the influence, which forms a series of Appeals in various directions.
- Level4-Discourse: appropriately conducted and more rigidly organized Interaction(s), which implies that Interactions occur in a particular order and appearance according to the definition of this Discourse.

Although we only used a subset of speech acts in our system, we argue that it is the relationship among these levels that link character dialogs (low levels) to narrative discourses (high levels). As indicated in the classification definition, there is a vital property that allows us to utilize this speech act model in narratives.

Property 1. (Speech Act Hierarchy): Being the higher linguistic functions imply being the lower ones.

That is, if a Discourse is described between two actors, it should contain one or more interactions, all of which lead to several Appeals in both directions. These Appeals occur with various (emotional) Expressions.

With this property, the plot symbols in narrative structures are expanded into one or more speech acts (which are later realized as dialogs) in addition to ordinary actions. For example, when two persons A and B argue about something in a play script (its the performance of which is sujet), if we describe this speech act as primitive actions in the domain theory of planning, this speech act can be illustrated as:

$$argue(A, B, sth) \tag{1}$$

During the process of argue, a number of forms of protocols must exist in the knowledge of both participants, such as rebut, undercut, and negotiate. These protocols contain a series of speech acts that designate verbal attacks and defenses toward each other, which may be chosen by both parties during the run time. When A and B execute these speech acts, they may also express their current emotions.

In the previous example, argue belongs to the Discourse (level-4); and rebut, undercut, and negotiate are its associated Interactions (level-3). Those attacks, defenses, and evasions that follow the Interaction protocols are Appeal (level-2), and their emotional behaviors are considered Expression (level-1).

Based on this property, we defined a *dialog frame* based on *speech acts* within narratives.

Definition 1. *(Speech Act): four major groups of speech acts occur, which are Expression, Appeal, Interaction, and Discourse, from low to high levels.*

A high level speech act may include speech acts from the lower levels.

Definition 2. *(Dialog Frame): a dialog frame must contain more than one speech act.*

Although these definitions do not provide precise information as to what type of speech acts are included in each model, we indicate the rules among each group. Although our focus was not to re-examine whether speech acts in each model are appropriate in human language, we provide several examples to demonstrate the manner in which these models are used as parameters for virtual drama, and explain the pros and cons with various approaches. The users are responsible for customizing their own sets of speech acts in each level, and the associated relations among these groups. Interested readers may refer to speech act classification for further details.

4 Virtual Drama

As stated in section 1, an automated virtual drama system must contain a minimum of 3 components, as follows: story generators to generate play scripts, virtual actors to play according to the scripts, and a virtual environment that integrates these components. Although the mechanism of story generation is outside the scope of this paper, we assume that the scripts are already generated as a sequence of high level actions such as those in [13][25]. Under this assumption, we specify the manner in which dialog frames are elaborated in virtual drama as these high level actions, and how virtual actors may improvise during the play of dialog frames.

4.1 Virtual Actors

To specify without losing generality, we define the schema of each component based on environment and autonomous agents of the SMART Agent Framework [9] in Z notation.

Virtual Enviromnent. The main difference between virtual drama systems and general agent systems is the existence of play scripts. These play scripts should be perceived by virtual actors to indicate the play, therefore, they must be defined in the virtual environment, above the original environment schema Env.

Definition 3. *(Virtual Environment)*

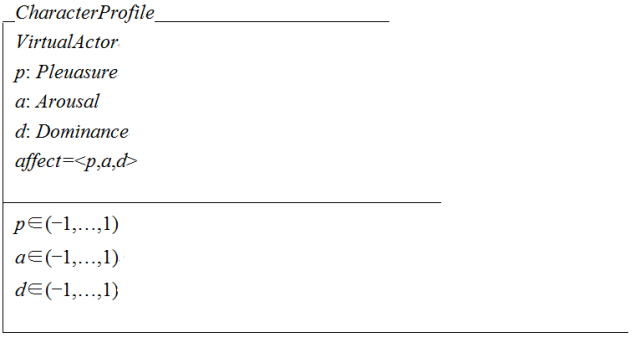
$$
\begin{array}{|l}
\textit{VirEnv} \\
\hline
\textit{Env} \\
\textit{virenv}: \textit{VirtualEnvironment} \\
\textit{socialcommitments}, \textit{socialrelations}: \\
\textit{AutonomousAgent} \times \textit{AutonomousAgent} \times \textit{Goals} \\
\textit{script}: \textit{Script} = \langle s1, s2, \cdots \rangle \\
\hline
\textit{script} \neq \{\} \\
\hline
\end{array}
$$

In Definition 3, the virtual environment includes not only play scripts, but also the social commitments and social relations among virtual actors. All of these attributes may affect the play of virtual actors. As Karunatillake et al. indicated, *since most (social) relationships involve the related parties carrying out certain actions for each other, we can view a relationship as an encapsulation of social commitments between the associated roles.*[16] We omitted the notion of social roles in favor of this notion, and only used them as parameters during the play, especially the play of dialog frames.

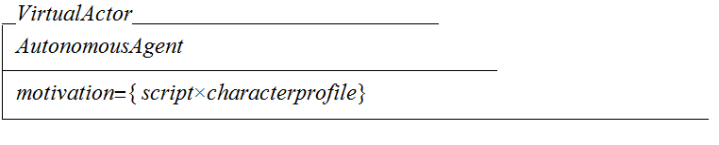
Character Profiles. In addition to social relations, the virtual actors should have particular internal parameters to maintain consistency between various states during the play to not interrupt the character believability, as proposed by Riedl and Young [26]. In addition to the intention of characters, we argue that the continuity of affective states also plays a vital role in maintaining character believability because if a character suddenly laughs whereas it cried a few minutes ago, this will cause unpredictable expressions to the audience. During a scene of dialogs, a virtual actor must be able to interact in various manners based on its affective states and the changes of affective states.

We defined the affective states as *character profiles*, following the ALMA affective model [12]. The reason that we used ALMA is due its elegant notation, which integrates emotions, mood, and personality in a single three-dimension space where the axes are pleasure, arousal, and dominance, rather than defining each of them in a different model [3][20][21].

Definition 4. *(Character Profile)*



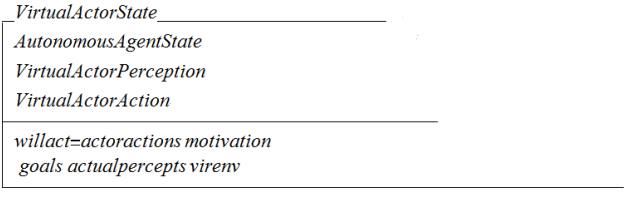
The difference between virtual actors and autonomous agents is its definition of motivation, which is based on script and character profiles.



Virtual Actors. Scripts and character profiles are independent of each other, although their combination determines the motivation of virtual actors. As we defined motivation in terms of scripts and character profiles, the definitions of agent perceptions and actions may not require further modification from those in autonomous agents because they percept and act upon virtual environments instead of environments. The action and perception schema of virtual actors was omitted to maintain the clarity of this paper.

Based on the previous definition, we may define the virtual actor state as follows:

Definition 5. *(Virtual Actor State)*



Three possible effects occur on the virtual environments and virtual actors during the play, as follows:

1. Change of character profiles, which change the motivation of virtual actors and leads to various choices of Interaction in the case of dialogs.
2. Change of social commitments, which lead to the change of available options in Interaction because social commitments serve as preconditions of Interaction.
3. Changes of scripts: because scripts are also a part of the virtual environment, the result of speech acts may also change the scripts and cause re-planning of scripts. Although we acknowledge its importance and effects, the topic of story re-planning is outside the scope of this paper.

Dialog Frame. The usage of dialog frames is summarized in this paragraph. First, because dialog frames are considered high level actions in a play script, the mapping of speech act models should also be specified in the script to provide virtual actors with available courses of actions during the play. Second, the character profiles of each virtual actor determine its goal selection on the courses of actions. Conversely, the effects of dialogs not only change character profiles, but also change social commitments, which alter the available options of speech acts within the script. Lastly, speech acts may also change scripts in the Discourse level, which leads to the re-planning of scripts.

4.2 Improvisation of Dialog Frames

Although dialog frames provide virtual actors with various options to select from during the play, these options are occasionally insufficient to reflect the character

profiles of virtual actors because a script is a linear sequence of action events. Although each event may be divided into various sub events (speech acts in lower levels), these sub events are limited to the script, and defining specialized mapping among speech act models for individual virtual actors is ad-hoc and inflexible. Based on Gebhards justification to the ALMA model [12], we propose an improvisation mechanism to achieve a higher degree of believability. This improvisation allows virtual actors to use particular speech acts in the Appeal and Expression levels to reflect extreme cases of character profile values and changes.

The add-on of improvisation mechanisms satisfies the previous specification of virtual actors. Because character profiles are one of the determinants of motivation, improvisation is defined in terms of affecting the thresholds and changes of $< p, a, d >$ vectors in virtual actors instead of virtual environments.

Furthermore, improvisation is triggered despite the current script, therefore, other virtual actors must be able to cope with improvisation at the time that improvisation occurs; otherwise, the behaviors that follow will contrast audience prediction and sabotage character believability. These coping behaviors are limited to insert right after improvisation occurs, and thus, the entire play script will not require re-planning. By defining the coping behaviors in secondary scripts parallel to play scripts, the virtual actors may conduct improvisation and coping speech acts by selecting various scripts to play, without re-planning the primary play scripts. The coping behaviors between improvised speech acts and coping speech acts are defined as follows:

Definition 6. *(Script of Coping Behaviors)*

$$
\begin{array}{|l}
\hline
\textit{CopingBehavior} \\
\textit{Script} \\
\textit{ImprovisedAct} \\
\textit{CopingAct} \\
\textit{copingbehaviors} == \textit{Script}: \textit{ImprovisedAct} \rightarrow \mathbb{P}\, \textit{CopingAct} \\
\hline
\textit{copingbehaviors} \neq \{\} \\
\hline
\end{array}
$$

The overview of dialog frames is illustrated in Fig. 2 with an intuitive script of a detective story, which is illustrated in section 6.

5 System Implementation

To demonstrate this dialog framework, we used a first-stage implementation of a virtual drama system according to the specifications. The system overview is illustrated in Fig 3.

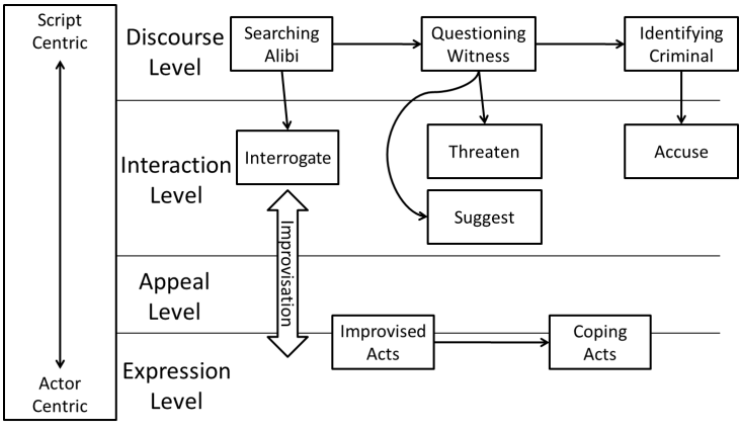


Fig. 2. Dialog Frames in Detective Scenario

The system was divided into two main parts, as follows:

1. Virtual Drama Server: The server was implemented with a JACK [15] agent platform because it supports the capacity, plan, and communication of autonomous agents. The Virtual Environment was also implemented in JACK as the data set. Consequently, the server may generate various sujet of play scripts in a plain-text format.
2. Visualization Frontend: The frontend is responsible for providing visual and audio experience for the audience of virtual drama. We chose the UDK3 (Unreal Development Kit 3) [32] as our frontend platform because it comprises a built-in full functional GUI editor and APIs that were written in Unreal Scripts that allowed us to write drama manager within it. Once the server passed sujet of a play script, the drama manager allocated the corresponding virtual actor, customized the SoundNodeWave library corresponding to speech acts with a built-in text-to-speech function, and gestures, all of which were regarded as parameters of matinee in cinematic mode.

At this stage of the implementation, the purpose of the virtual drama system was to achieve full automation of sujet performance; therefore, user interaction was not implemented to simplify the process.

6 Sample Scenarios

In this section, we provide a sample scenario to demonstrate the effect of dialog frames in our implemented system, which is illustrated in Fig. 3.

This sample scenario is a typical detective story, as the play script only contains three high level speech actions in Discourse, as follows: search for alibi, question the witness, and identify the criminal. Assuming that this play script is

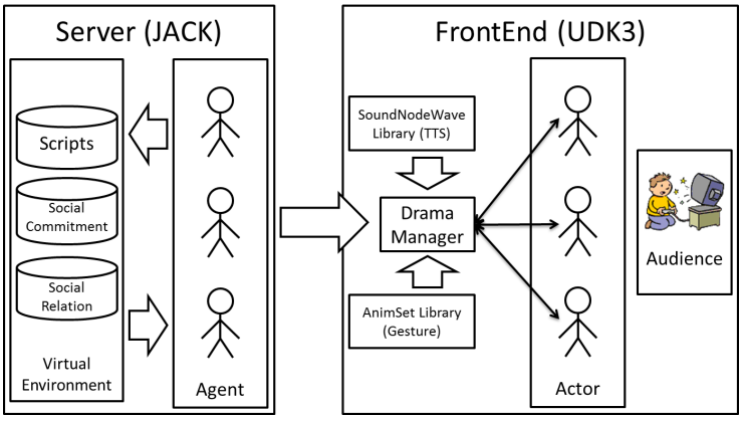


Fig. 3. System Implementation Overview

sufficiently simple to be generated by state-of-the-art story planners; our system was demonstrated the following functionalities:

1. Our dialog framework simplified each speech act into the Interaction level, which corresponds to various interaction protocols.
2. When these protocols were provided as dialog options, each virtual actor chose protocols in which the preconditions matched its character profiles while playing that part of the script.
3. Improvised dialogs may occur during the play, because each move in the Interaction protocol affects the character profiles of the opponent, which triggers improvisation in the stipulated thresholds. After improvisation, the virtual actors return to the former part of the script and continue the main storyline.

7 Conclusion and Future Work

The development of story planning led to the possibility of an automated drama system, in which play scripts are generated by story generators and subsequently played by virtual actors in a virtual environment with the ability of visual and audio expression. Although few studies attempted to generate dialogs based on the provided fabula, we used speech act classification that was derived from empirical studies of speech act designating verbs to generate dialog in a virtual drama. This study offers three contributions, as follows:

1. We propose a dialog framework with the ability to promote flexible dialog selection and to improvise character-based dialogs from existing play scripts.
2. The core specifications of virtual actors and virtual environment are specified in Z notation to elaborate the desiderata of virtual drama components without losing generality.

3. A first-stage virtual drama system was implemented to demonstrate the selection of dialogs during a sample scenario.

Although the initial results were satisfactory, several components must be addressed in future studies to achieve a fully automated virtual drama system, as follows:

1. Generating natural dialogs from speech acts to advance the automation of dialogs.
2. Treating Discourse-level speech acts as vignettes [27] in story planning may lead to improvements in script generation. Because Discourse-level speech acts are combinations of Interaction-level protocols, they may represent a source of vignettes.
3. The domain knowledge of speech acts and their parameters may be further elaborated as more structured data, therefore, virtual actors may reason with the play script rather than profile-based selection in the available options.

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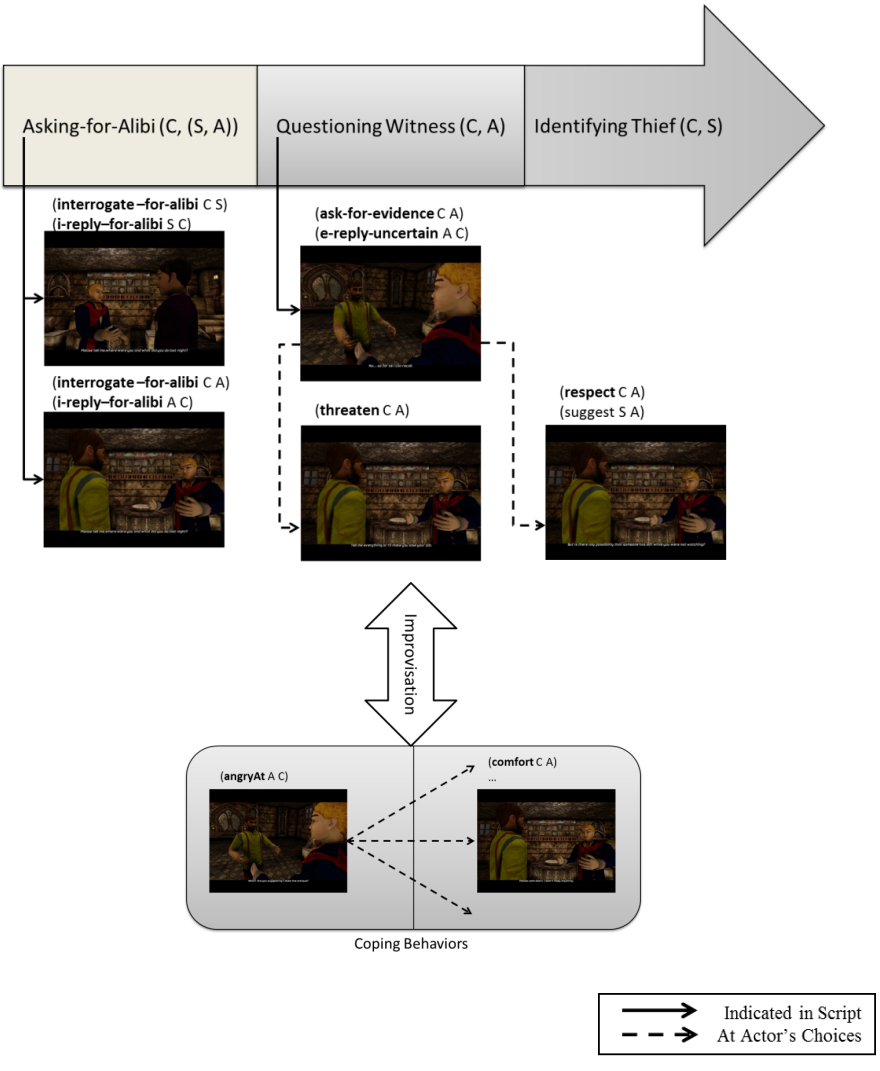
Appendix


Asking-for-Alibi (C, (S, A))
Questioning Witness (C, A)
Identifying Thief (C, S)
(interrogate –for-alibi C S)
(i-reply–for-alibi S C)
(interrogate –for-alibi C A)
(i-reply–for-alibi A C)
(ask-for-evidence C A)
(e-reply-uncertain A C)
(threaten C A)
(respect C A)
(suggest S A)
Improvisation
(angryAt A C)
(comfort C A)
...
Coping Behaviors
Indicated in Script
At Actor's Choices